

MINISTRY OF HEALTH OF UKRAINE
ODESA NATIONAL MEDICAL UNIVERSITY
Department of Medical Biology and Chemistry

CONFIRMED by
Vice-rector for scientific and
pedagogical work
Eduard BURIACHKIVSKYI

“ 1 ” 09 2024

WORKING PROGRAM IN THE DISCIPLINE
"APPLIED CHEMISTRY IN MEDICINE"

Level of higher education: second (master's degree)

Field of knowledge: 22 "Health care"

Specialty: 222 "Medicine"

Educational and professional program: Medicine

The program is based on the educational-professional program "Medicine", training of the second (master's) level of higher education in the specialty 222 "Medicine" in the field of knowledge 22 "Health", approved by the Academic Council of ONMedU, from 29.06.2024, protocol № 8.

Developers:

Assoc.Prof. Stepanov G.F,

Assoc.Prof. Burdina Ia.F.

Assoc.Prof. Grekova A.V.

The program was discussed at a meeting of the Department of Clinical Chemistry and Laboratory Diagnostics
Protocol № 1 dated 26.08.2024

Head of the Department


Gennady STEPANOV

Approved by the guarantor of
the educational and professional program


Valeriia MARICHEREDA

Approved by the Subject and Cyclical Methodological Commission on Medical and Biological Disciplines of ONMedU.

Protocol № 1 dated 27.08.2024

Head of the Subject Cycle Methodological Commission for Medical and Biological Disciplines at ONMedU


Leonid GODLEVSKYI

Reviewed and approved at the department meeting

Protocol № ___ dated _____ 2024

Head of Department _____

(signature)

(First Name Surname)

Reviewed and approved at the department meeting

Protocol № ___ dated _____ 2024

Head of Department _____

(signature)

(First Name Surname)

1. Description of the discipline:

Name of indicators	Field of knowledge, specialty, specialization, level of higher education	Characteristics of the discipline
The total number of: Credits - 3.0 Hours - 90 Content sections - 1	Branch of knowledge 22 "Health care"	<i>Full-time education</i> <i>Mandatory discipline</i>
	Specialty 222 "Medicine"	<i>Year of preparation: 1</i>
		<i>Semester II</i>
		<i>Lectures (0 hours)</i>
		<i>Seminars (0 hours)</i>
		<i>Practical classes (30 hours)</i>
		<i>Laboratory work (0 hours)</i>
		<i>Individual work (60 hours)</i>
		<i>Including individual tasks (0 hours)</i>
	<i>Form of final control –credit test</i>	

2. The purpose and tasks of the educational discipline, competencies, program learning outcomes

Aims: formation of systematic knowledge of doctors about the basic physical and chemical laws of biochemical processes and the action of drugs in the body of each person at the molecular and cellular levels; about the structure and properties of colloidal-dispersed systems; about the structure and mechanisms of functioning of biologically active compounds; about the structure and mechanisms of functioning of polymers; to show the importance of chemistry in life, the specifics of the use of chemicals in domestic processes, the impact of synthetic chemicals on the environment; the ability to conduct experiments.

Objectives:

1. To increase the level of theoretical training of students.
2. To provide students with an understanding of the content of chemical phenomena occurring in a living organism, to use chemical laws in the diagnosis and treatment of diseases, to be able to understand the physicochemical principles of action of drugs used in modern medicine.
3. To develop students' skills of studying scientific chemical literature, ability to solve problem and situational tasks;

The process of studying the discipline is aimed at forming elements of the following competencies:

- **General competences (GC):**

- GC1 - Ability to abstract thinking, analysis and synthesis.
- GC2 - Ability to know and understand the subject area and professional activities.
- GC3 - Ability to communicate in the state language.
- GC4 - Ability to learn and master modern knowledge, use information and communication technologies; ability to search, process and analyze information from various sources.
- GC7 - Ability to evaluate and ensure the quality of work performed.
- GC8 - Ability to act on the basis of ethical considerations, socially, responsibly and consciously.
- GC11 - Ability to search, process and analyze information from various sources
- GC16 - Ability to evaluate and ensure the quality of work performed
- GC17 - Striving to preserve the environment.

- **Special competence (SC):**

- SC2. Ability to determine the necessary list of laboratory and instrumental studies and evaluate their results.
- SC23. Ability to develop and implement scientific and applied projects in the field of health care.
- SC24. Compliance with ethical principles when working with patients, laboratory animals.
- SC25. Adherence to professional and academic integrity, responsibility for the reliability of scientific results.
- SC28. Ability to apply fundamental biomedical knowledge at a level sufficient to perform professional tasks in the field of health care.

Program learning outcomes (PLO)

PLO1. Have a thorough knowledge of the structure of professional activity. Be able to carry out professional activities that require updating and integration of knowledge. Be responsible for professional development, the ability to further professional training with a high level of autonomy.

PLO2. Understanding and knowledge of basic and clinical biomedical sciences at a level sufficient to solve professional problems in the field of health care.

PLO21. Search for necessary information in professional literature and databases of other sources, analyze, evaluate and apply this information.

PLO24. To organize the necessary level of individual safety (own and persons taken care of) in case of typical dangerous situations in the individual field of activity.

As a result of studying the discipline, the student should:

Know:

- Application of the main types and classes of bioactive organic and inorganic compounds;
- Features of structure, isomerism, characteristic properties of the main classes of bioorganic compounds and methods of their identification;
- Stereochemical features and their influence on the biological properties of substances;
- Fundamentals of vital mechanisms at the molecular level;
- The main stages of biotransformation of drugs in the body;
- Basic gases and gas mixtures used in medicine; safety rules for their use;
- Toxic elements for the human body, mechanisms of poisoning by chemical elements and drugs;
- Composition and mechanisms of influence of beverage components on the human body;
- Basic composition of food products; food additives and their properties;
- Basic polymeric materials used in medicine. The concept of biocompatibility of polymeric materials.

Be able to:

- Use educational, scientific, popular science and reference literature, the Internet;
- Predict the results of chemical transformations of inorganic and organic compounds;
- Judge the probability and direction of biochemical reactions;
- Characterize solutions of non-electrolytes and electrolytes, calculate their concentration;
- Apply chemical methods of quantitative and qualitative analysis;
 - To characterize the quantitative composition of solutions;
- Draw conclusions about the acidity of biological fluids based on the hydrogen index;
- Explain the mechanism of action of buffer systems and their role in maintaining acid-base balance in biological systems;

- Interpret the physicochemical properties of proteins, which are the structural components of all tissues of the body, draw conclusions about the charge of dissolved biopolymers.

3. Content of the discipline

Content module 1.

Applied chemistry in medicine

Topic 1: Toxicologically important substances: inorganic, organic and carcinogenic compounds, metals, teratogens and addictive substances.

Selected inorganic substances - ozone, silicon dioxide, hydrocyanic acid, carbon monoxide, nitrides, sulfides. Metals - cadmium, barium, mercury, lead. Selected organic compounds - benzene, toluene, polycyclic hydrocarbons, methanol, ethylene glycol. Carcinogenic substances.

Theme 2. Water in living systems. The role and content of water in the human body. Determination of total, temporary and permanent hardness of water.

The structure of water. Biological importance of water. Water content in the human body. The role of water in the human body. Free and bound water in food. Determination of the total moisture content in food. Determination of water hardness. Determination of temporary and permanent hardness of water.

Topic 3. Solutions. Preparation of solutions with a given quantitative composition. Solutions for the provision of first aid.

Solutions in vital activity. Enthalpy and entropy factors of dissolution and their relationship with the mechanism of dissolution. Solubility of liquids and solids. Distribution of substances between two liquids that do not mix. Nernst's law of distribution, its importance in the phenomenon of permeability of biological membranes. Preparation of solutions of a given composition.

Topic 4. Solubility and lipophilicity of drug molecules. Relationship between pharmacological activity and ionization of molecules. Infusion solutions.

The role of water influence on the pharmacological activity of drug molecules. The concept of solubility and lipophilicity of drug molecules; the influence of functional groups and carbon skeleton. Concentration of drug solutions. Conversion of concentrations according to the prescription. Influence of pH on the solubility of acid and basic drugs. Ionization of molecules of biologically active compounds.

Preparation of electrolyte solutions. Functional classification of infusion drugs and features of its use. Ionization constant and its influence on the pharmacological activity of molecules. Acid-base homeostasis, acidosis and alkalosis. Buffer systems and their influence on the action of drugs.

Topic 5. Medical solutions: antiseptics, disinfectants. Water purification and sterilization of medical devices and instruments in the field.

Hand hygiene, work surfaces in case of viral and bacterial infections. Classification of antiseptic and disinfectant liquids. Algorithm for the preparation of detergent and disinfectant solutions. Water purification in the field. Means for disinfection of surfaces of premises, medical devices.

Topic 6. Medical gases: production, use and safety. Dosing of gas mixtures for inhalation anesthesia. Solubility of gases.

Properties of gases, gas laws. Air, its composition. Analysis of the composition of exhaled air for diagnostic purposes. Medical oxygen: production, operation, safety rules. Oxygen

therapy. Mountain air, hypoxia therapy. Singlet oxygen therapy, ozone therapy. Noble gases in medicine. Gas mixtures for anesthesia. Xenon, production of medical xenon. Radon therapy. Solubility of gases in liquids and its dependence on various factors. Henry-Dalton law. Effect of electrolytes on the solubility of gases (Sechenov's law). Solubility of gases in blood. Caisson disease.

Topic 7. Surfactants and their importance in human life. Chemistry of tensides and detergents (synthetic detergents, shampoos, gels, bath foams).

Surface active substances of biological origin. Influence of surfactants on the human body. Influence of surfactants on living systems. Classification of surfactants and their action in synthetic detergents. Shampoos: classification, properties, application. Mechanism of detergent action of foaming cosmetics. Compositions of surfactants in the cosmetic industry. Typical formulation of face and body skin care products: moisturizing creams, nourishing creams, creams with biostimulating and regenerating properties, day and night creams, acne treatment preparations, sunscreen creams, hand creams, lotions. Typical formulation of decorative cosmetics: lipsticks, mascara, foundation. Shaving products. Toothpastes. Special soaps. Deodorants. Shampoos, shower gels. Compositions of food surfactants. Composition of monoglycerides and mixtures of mono- and diglycerides. Typical emulsifying compositions.

Topic 8: High molecular weight compounds. Properties and features of biopolymer solutions. Application of HMC solutions in medical practice.

Classification of HMC. Natural high molecular weight compounds. Structural organization of biopolymers. Comparative characteristics of HMC solutions, true and colloidal solutions. Swelling and dissolution of polymers. Medical properties of HMC solutions. Ionic state of biopolymers in aqueous solutions. Isoelectric state of proteins. Dragling. Properties of gels. Abnormal viscosity of HMC solutions. Viscosity of blood. Donnan's membrane equilibrium.

Topic 9: Polymers of medical and biological application: structure and functions. Medical and pharmaceutical application of polymeric materials.

Biopolymers in medical practice: bioinert (polysiloxanes, polyacrylates, polyethylene, polyamides, polyurethanes, polyester, natural (collagen and gelatin, fibrin, polysaccharide hydrogels, cellulose fiber composites, glucosamine, alginates, chitin and chitosan, dextran), bioabsorbable (biodegradable). Sterilization of polymer implants. Polymers used in reconstructive surgery, cardiovascular surgery, traumatology and orthopedics, ophthalmology. Polymer devices for targeted drug delivery. Polymer suture materials and polymer adhesives for medical purposes. Blood and plasma substitutes. Prolongers. Packaging for medicinal products and medical devices.

Topic 10. Chemical quality control of beverages.

Human health and beverage safety issues. Natural components of food raw materials that adversely affect the human body. Social toxicants. Standardization of contaminants in beverages. The influence of beverages on the intake of medicines.

Topic 11: Food products, their quality.

Chemistry of food additives, preservatives, dietary supplements. Human health and food safety issues. Potentially hazardous food contaminants and their effects.

Topic 12: Sorption of biologically active substances at the interface. Adsorbents in modern medicine. Sorbents in food poisoning. Chromatography.

Sorbents and enterosorbents. Pharmacological properties of carbon enterosorbents. Adsorption of acetic acid on activated carbon. Principles of treatment of acute poisoning. Basic

antidotes. Classification of chromatographic methods of analysis by the mechanism of distribution. Adsorption, ion exchange and distribution chromatography. Application of chromatography in biomedical research.

Topic 13: Chemical weapons. Means of protection and first aid.

Personalities of chemical weapons. Characteristics of the focus of chemical contamination. Defeat by chemical warfare agents, measures to counter it.

Topic 14: Fundamentals of nanochemistry. Nanotechnology in medicine.

Basic concepts and terms of nanochemistry. Classification of nanoobjects. Methods of synthesis of nanoparticles. Carbon nanomaterials. Porous nanoobjects. Liposomes. The role of nanotechnology in the diagnosis of diseases. Nanodevices - nanorobots. The use of nanosystems as drug carriers. The use of nanotechnology in oncology, neurology, cardiology and other fields of medicine. Nanocosmetics.

Topic 15: Final control of knowledge: credit.

4. The structure of the discipline

Topics	Number of hours					
	total	Including				
		lectures	seminars	practical	laboratory	ISW
Content module 1.						
Topic 1: Toxicologically important substances: inorganic, organic and carcinogenic compounds, metals, teratogens and addictive substances.	6	0	0	2	0	4
Theme 2. Water in living systems. The role and content of water in the human body. Determination of total, temporary and permanent hardness of water.	6	0	0	2	0	4
Topic 3. Solutions. Preparation of solutions with a given quantitative composition. Solutions for the provision of first aid.	6	0	0	2	0	4
Topic 4. Solubility and lipophilicity of drug molecules. Relationship between pharmacological activity and ionization of molecules. Infusion	6	0	0	2	0	4

solutions						
Topic 5. Medical solutions: antiseptics, disinfectants. Water purification and sterilization of medical devices and instruments in the field.	6	0	0	2	0	4
Topic 6. Medical gases: production, use and safety. Dosing of gas mixtures for inhalation anesthesia. Solubility of gases.	6	0	0	2	0	4
Topic 7. Surfactants and their importance in human life. Chemistry of tensides and detergents (synthetic detergents, shampoos, gels, bath foams).	6	0	0	2	0	4
Topic 8: High molecular weight compounds. Properties and features of biopolymer solutions. Application of HMC solutions in medical practice.	6	0	0	2	0	4
Topic 9. Polymers of biomedical application: structure and functions. Medical and pharmaceutical applications of polymeric materials.	6	0	0	2	0	4
Topic 10. Chemical quality control of beverages.	6	0	0	2	0	4
Topic 11. Food products, their quality.	6	0	0	2	0	4
Topic 12. Sorption of biologically active substances at the interface. Adsorbents in modern medicine. Sorbents in food poisoning. Chromatography.	6	0	0	2	0	4
Topic 13: Chemical weapons. Protective equipment and first aid.	6	0	0	2	0	4

Topic 14. Fundamentals of nanochemistry. Nanotechnology in medicine.	6	0	0	2	0	4
Total for content module 1	48	0	0	16	0	32
Topic 15: Final control of knowledge: credit.	6	0	0	2	0	4
Individual tasks	0	0	0	0	0	0
Total hours	90	0	0	30	0	60

5. Topics of lectures / seminars / practical / laboratory classes

5.1. Topics of lectures

Lectures are not provided.

5.2. Topics of seminars

Seminars are not provided.

5.3. Topics of practical classes

№	Topics	Number of hours
1.	Topic 1: Practical training 1. Toxicologically important substances: inorganic, organic and carcinogenic compounds, metals, teratogens and addictive substances.	2
2.	Topic 2. Practical lesson 2. Water in living systems. The role and content of water in the human body. Determination of total, temporary and permanent hardness of water.	2
3.	Topic 3. Practical lesson 3. Solutions. Preparation of solutions with a given quantitative composition. Solutions for first aid.	2
4.	Topic 4. Practical lesson 4. Solubility and lipophilicity of drug molecules. Relationship between pharmacological activity and ionization of molecules. Infusion solutions.	2
5.	Topic 5. Practical lesson 5. Medical solutions: antiseptics, disinfectants. Water purification and sterilization of medical devices and instruments in the field.	2
6.	Topic 6. Practical lesson 6. Medical gases: production, use and safety. Dosing of gas mixtures for inhalation anesthesia. Solubility of gases.	2
7.	Topic 7. Practical lesson 7. Surfactants and their importance in human life. Chemistry of tensides and detergents (synthetic detergents, shampoos, gels, bath foams).	2
8.	Topic 8. Practical lesson 8. High molecular weight compounds. Properties and features of biopolymer solutions. Application of HMC solutions in medical practice..	2
9.	Topic 9. Practical lesson 9. Polymers of biomedical application: structure and function. Medical and pharmaceutical applications of polymeric materials.	2
10.	Topic 10. Practical lesson 10.	2

	Chemical quality control of beverages.	
11.	Topic 11. Practical lesson 11. Normal porphyrin metabolism. Stages of heme biosynthesis. Pathology of porphyrin metabolism. Porphyria: classification, pathogenesis, clinical manifestations, laboratory diagnosis. Laboratory parameters for some diseases and intoxications accompanied by porphyrin metabolism disorders.	2
12.	Topic 12 Practical lesson 12. Sorption of biologically active substances at the interface. Adsorbents in modern medicine. Sorbents in food poisoning. Chromatography.	2
13.	Topic 13. Practical lesson 13. Chemical weapons. Protective equipment and first aid.	2
14.	Topic 14. Practical lesson 14. Fundamentals of nanochemistry. Nanotechnology in medicine.	2
15.	Topic 15. Practical lesson 15. Final control of knowledge: credit.	2
	Total	30

5.4. Topics of laboratory classes

Laboratory classes are not provided.

6. Independent work of a student of higher education

№	Types of IWS	Hours
1.	Topic 1. Preparation for practical lesson 1	4
2.	Topic 2. Preparation for practical lesson 2	4
3.	Topic 3. Preparation for practical lesson 3	4
4.	Topic 4. Preparation for practical lesson 4	4
5.	Topic 5. Preparation for practical lesson 5	4
6.	Topic 6. Preparation for practical lesson 6	4
7.	Topic 7. Preparation for practical lesson 7	4
8.	Topic 8. Preparation for practical lesson 8	4
9.	Topic 9. Preparation for practical lesson 9	4
10.	Topic 10. Preparation for practical lesson 10	4
11.	Topic 11. Preparation for practical lesson 11	4
12.	Topic 12. Preparation for practical lesson 12	4
13.	Topic 13. Preparation for practical lesson 13	4
14.	Topic 14. Preparation for practical lesson 14	4
	Hours in general	60

7. Teaching methods

Practical classes:

- verbal methods: conversation, explanation, discussion, discussion of problem situations;
- visual methods: illustration (including multimedia presentations).

Independent work: independent work with the recommended basic and additional literature, with electronic information resources, preparation for practical classes; independent solution of situational problems.

8. Forms of control and evaluation methods (including criteria for evaluating learning outcomes)

Ongoing / current control: oral examination, assessment of practical skills, solving situational problems, assessment of activity in the classroom.

Differentiated scoring: carried out with the help of written work (tasks and exercises, the implementation of which requires mandatory motivation, as well as situational tasks): 3 tasks of the II level of complexity and 2 tasks of the III level of complexity.

The structure of the current assessment in the practical lesson:

1. Assessment of theoretical knowledge on the topic of the lesson:
 - methods: questioning, solving a situational problem;
 - maximum score - 5, minimum score - 3, unsatisfactory score - 2.
2. Assessment of practical skills on the topic of the lesson:
 - methods: assessment of the correctness of practical skills
 - maximum grade - 5, minimum grade - 3, unsatisfactory grade - 2;

Criteria for ongoing assessment in the practical lesson:

Score	Assessment criterion
Excellent «5»	The student is fluent in the material, takes an active part in the discussion and solution of the situational problem, confidently demonstrates practical skills in the interpretation of laboratory tests, expresses his opinion on the topic of the lesson.
Good «4»	The student is well versed in the material, participates in the discussion and solution of the situational problem, demonstrates practical skills during and interpretation of laboratory tests with some errors, expresses his opinion on the topic of the lesson.
Satisfactory «3»	The student does not have enough material, uncertainly participates in the discussion and solution of a situational problem with significant errors.
Unsatisfactory «2»	The student does not have the material, does not participate in the discussion and solution of the situational problem, does not demonstrate practical skills.

The student is admitted to the final control on condition of attendance of all classes, absence of academic debt and if the average score for the current educational activity is not less than 3.00.

Students who have fully completed the curriculum in the discipline, do not have academic debt, their average grade point average is 3.00 or more, at the last lesson receive a credit that is set as "passed" / "not passed".

Conversion of the traditional national grade into a multi-point grade (maximum 200 points) is mandatory.

9. Distribution of points received by applicants for higher education

The average grade for a discipline is converted into a national grade and converted into points on a multi-point scale (200-point scale).

The conversion of the traditional grade to 200 points is performed by the Information Technology Department of the University by the "Contingent" program according to the formula:

Grade point average (current academic performance in the discipline) x 40

Table of converting the traditional grade into a multi-point grade

National score for the discipline	The sum of scores for the discipline
Excellent («5»)	185 – 200
Good («4»)	151 – 184
Satisfactory («3»)	120 – 150
Unsatisfactory («2»)	Less than 120

According to the ECTS rating scale, the achievements of students in the educational component, who study at the same course of one specialty, are evaluated according to the points they received, by ranking, namely:

Assessment on the ECTS scale	Statistical indicator
A	The best 10% of students
B	The next 25% of students
C	The next 30% of students
D	The next 25% of students
E	The next 10% of students

10. Methodical support:

- Work program of the discipline
- Silabus
- Methodical developments for practical classes
- Methodical recommendations for independent work of higher education applicants
- Multimedia presentations
- Situational tasks

11. Questions for preparation for the final control

1. Toxicologically important substances: inorganic, organic and carcinogenic compounds.
2. The role and content of water in the human body.
3. Determination of total, temporary and permanent hardness of water.
4. Preparation of solutions with a given quantitative composition.
5. Infusion solutions.
6. Medical solutions: antiseptics, disinfectants.
7. Water purification and sterilization of medical devices and instruments in the field.
8. Production, use and safety of medical gases.
9. Surfactants and their importance in human life.
10. Polymers of biomedical application: structure and function.
11. Chemical quality control of beverages and food products.
12. Adsorbents in modern medicine.

12. Literature

Basic literature:

1. The Chemistry of Medical and Dental Materials, 2nd Edition By John W. Nicholson 2020. Published by the Royal Society of Chemistry -251 p. - ISBN: 978-1-78801-530-1
2. Narayan R. (Ed.) Biomedical Materials 2nd Edition. — Springer, 2021. — 720 p.
3. General and Inorganic Chemistry: textbook / V.O. Kalibabchuk, V.V. Ohurtsov, V.I. Halynska et al. – Kyiv, AUS Medicine Publishing, 2019. – 456 p.

4. William Marshall, Marta Lapsley, Andrew Day, Kate Shipman. *Clinical Chemistry*. – Elsevier, 2020, - 432 p.
5. *Textbook of Medicinal Chemistry* / [V. Alagarsamy](#) // CBS Publishers & Distributors Pvt Ltd, India; 3rd edition, 2018 – 584 p.
6. Richard Post. *Chemistry: Concepts and Problems* / Richard Post, Chad Snyder, Clifford C. Houk // *A Self-Teaching Guide*, Jossey-Bass, 2020. – 432 p.
7. Darrell D. Ebbing. *General Chemistry* / Darrell D. Ebbing, Steven D. Gammon. – Boston: Cengage Learnin, 2017. – 1190 c. – (Eleventh Edition).

Additional literature:

1. *Medical Biochemistry*/ Baynes J., Dominiczak M.. – Saunders, Elsevier, 2018. – 712 p.
2. *Lippincott Illustrated Reviews: Biochemistry*/Ferrier D. – Philadelphia :Wolters Kluwer, 2017. – 560 p.
3. *Medical Chemistry: textbook* / V.Y. Tsuber, A.A. Kotvytska, K.V. Tykhonovych et al. – Kyiv, AUS Medicine Publishing, 2022. – 392 p.
4. *Medical chemistry: a textbook for universities* / V. O. Kalibabchuk, I. S. Chekman, V. I. Galynska and others; for ed. Prof. V. O. Kalibabchuk – 4th ed. – K. VSV "Medicine", 2019 – 336 p.
5. *Medical chemistry* / V.O. Kalibabchuk, V.I. Halynska, L.I. Hryshchenko et al. – Kyiv, AUS Medicine Publishing, 2020. – 224 p.

13. Electronic information resources

1. <http://moz.gov.ua> - Ministry of Health of Ukraine
2. www.who.int - World Health Organization
3. www.dec.gov.ua/mtd/home/ - State Expert Center of the Ministry of Health of Ukraine
4. <http://bma.org.uk> - British Medical Association
5. www.gmc-uk.org - General Medical Council (GMC)
6. www.bundesaerztekammer.de - German Medical Association